CLAIMS

What is claimed is:

1. A complex sigma-delta modulation method, comprising:

receiving a complex input signal having a real component and an imaginary component;

applying a first complex sigma-delta modulation process to the complex input signal to produce a first sigma-delta modulated signal;

applying a second complex sigma-delta modulation process to the first sigma-delta modulated signal to produce a second sigma-delta modulated signal; and

conditioning the first and second sigma-delta modulated signals using a complex noise cancellation process to produce an output signal.

2. The complex modulation method of claim 1, the first and second complex sigma-delta modulation processes each comprising multiple-order sigma-delta modulation processes.

3. The method of claim 1, the receiving step comprising:

receiving a radio frequency modulated signal; and

down-converting the radio frequency modulated signal to produce the complex input signal.

4. The complex modulation method of claim 3, the down-converting step comprising:

mixing the radio frequency modulated signal with first and second quadrature local oscillator signals to produce the complex input signal.

5. An analog-to-digital converter, comprising:

an input for receiving an input signal having real and imaginary components;

a first complex sigma-delta modulator for modulating the input signal to produce a first sigma-delta modulated output signal;

a second complex sigma-delta modulator coupled to the first complex sigma-delta modulator, for converting the first sigma-delta modulated signal into a second sigma-delta modulated signal; and

a complex digital noise cancellation circuit, coupled to the first and second complex sigma-delta modulators, for canceling quantization noise and to produce a converter output signal from the first and second sigma-delta modulated output signals.

6. The analog-to-digital converter of claim 5, the first and second sigma-delta modulators including real integrators.

7. The analog-to-digital converter of claim 5, the first complex sigma-delta modulator comprising a multiple-order sigma-delta modulator circuit.

8. The analog-to-digital converter of claim 7, the multiple-order sigma-delta

modulator circuit including real integrators.

9. The analog-to-digital converter of claim 5, the second complex sigma-delta modulator comprising a multiple-order sigma-delta modulator circuit.

10. The analog-to-digital converter of claim 9, the multiple-order sigma-delta modulator circuit including real integrators.

11. A complex modulator, comprising:

an input for receiving a baseband input signal having a real and an imaginary component;

a complex analog-to-digital converter for converting one of the real and imaginary components of the input signal into a quantized real output signal and a quantized imaginary output signal; and

a complex digital filter for filtering the complex real and imaginary output signals to produce a real filtered output signal.

12. The complex modulator of claim 11, the complex analog-to-digital converter, comprising:

a first complex sigma-delta modulator for converting the one of the real and imaginary components of the input signal to produce a first sigma-delta modulated output signal; and

a second complex sigma-delta modulator coupled to the first complex sigma-delta modulator, for converting the first sigma-delta modulated signal

into the quantized real output signal and the quantized imaginary output signal.

13. The complex modulator of claim 11, further comprising:

a radio frequency signal receiver for producing the baseband input signal.

14. The complex modulator of claim 13, the radio frequency receiver comprising:

an antenna circuit for receiving a modulated radio frequency signal; and

a down-converter, coupled to the antenna circuit, for converting the modulated radio frequency signal into a baseband signal centered about DC.

15. The complex modulator of claim 14, the down-converter comprising:

a mixer for mixing the modulated radio frequency signal with first and second quadrature local oscillator signals to produce the baseband input signal.

16. A radio frequency receiver, comprising:

an input for receiving a modulated radio frequency signal;

a down converter coupled to the input for converting the modulated radio frequency signal into an input signal having real and imaginary components;

an analog to digital converter coupled to the down converter, comprising:

a first stage including a complex sigma-delta modulator and having a first stage output; and

a second stage coupled to the output of the first stage including a

complex sigma delta modulator, and having a second stage output; and

a complex digital noise cancellation circuit coupled to the outputs of the first and second stages, for canceling quantization noise and for producing a digitized output signal.

17. A radio frequency receiver, comprising:

an input for receiving a modulated radio frequency signal;

a down converter coupled to the input for converting the modulated radio frequency signal into a baseband input signal having real and imaginary components;

a complex sigma-delta analog to digital converter coupled to the down converter, for converting only one of the real and imaginary components of the input signal into a complex digitized output signal; and

a complex digital filter coupled to the complex sigma-delta analog to digital converter, for producing a real filtered output signal from the complex digitized output signal.